Next Generation Space Internet: Standards and Implementation

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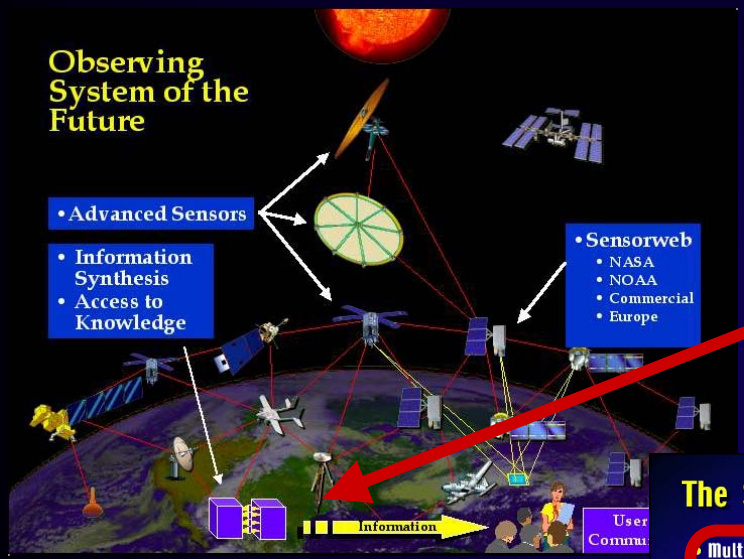
AGENDA

- Future mission requirements & assumptions
- NGSI services
- Standardization
- Implementation

Future Mission Requirements

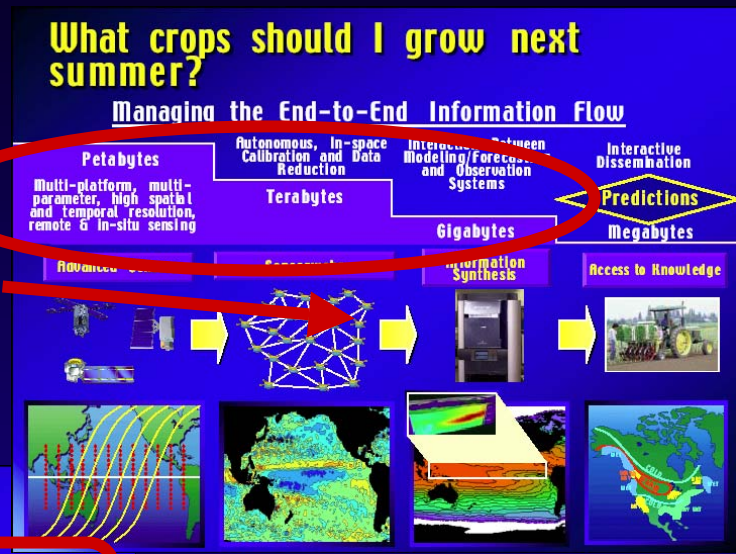


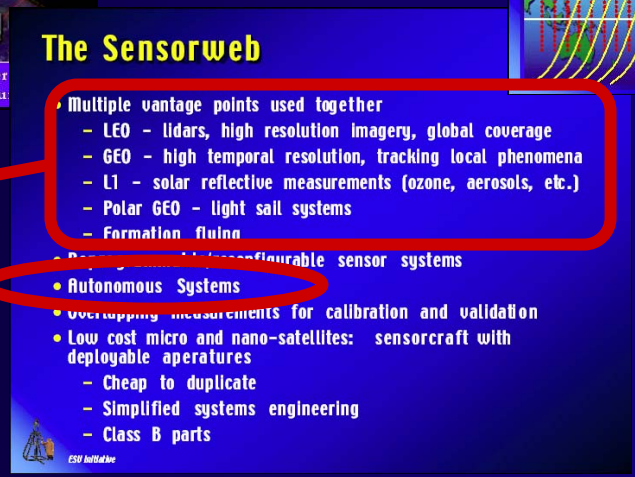
Large Data Sets

Internet Connectivity

Networks

Autonomous Spacecraft



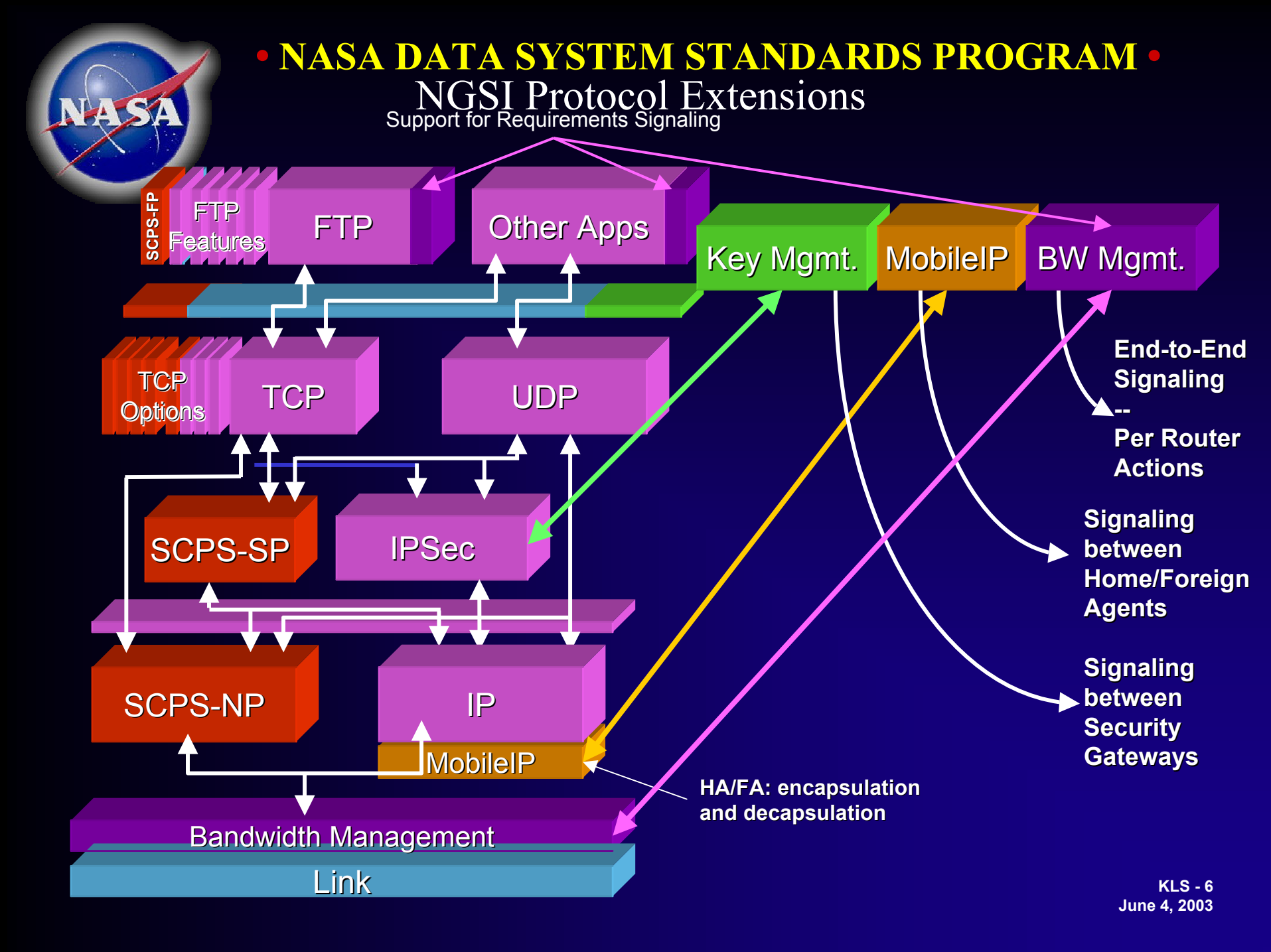


Challenges

- Connectivity
  - Point of attachment between orbiting sensor net and the Internet changes
- Security
  - Your spacecraft is at 66.170.238.241? I always wanted my own spacecraft…
- Efficiency
  - Large data sets require efficiency, especially across the space-to-ground link

Approach

- Standardized protocols / extensions allowing multiple vendor implementations:
  - Security gateways
  - Advanced IP Mobility
  - Resource Reservation
- Proof-of-concept implementation


• NASA DATA SYSTEM STANDARDS PROGRAM •
NGSI Protocol Extensions
Support for Requirements Signaling
SCPS-FP
FTP Features
FTP
Other Apps
Key Mgmt.
MobileIP
BW Mgmt.
TCP Options
TCP
UDP
SCPS-SP
IPSec
SCPS-NP
IP
MobileIP
Bandwidth Management
Link
End-to-End Signaling -- Per Router Actions
Signaling between Home/Foreign Agents
Signaling between Security Gateways
HA/FA: encapsulation and decapsulation
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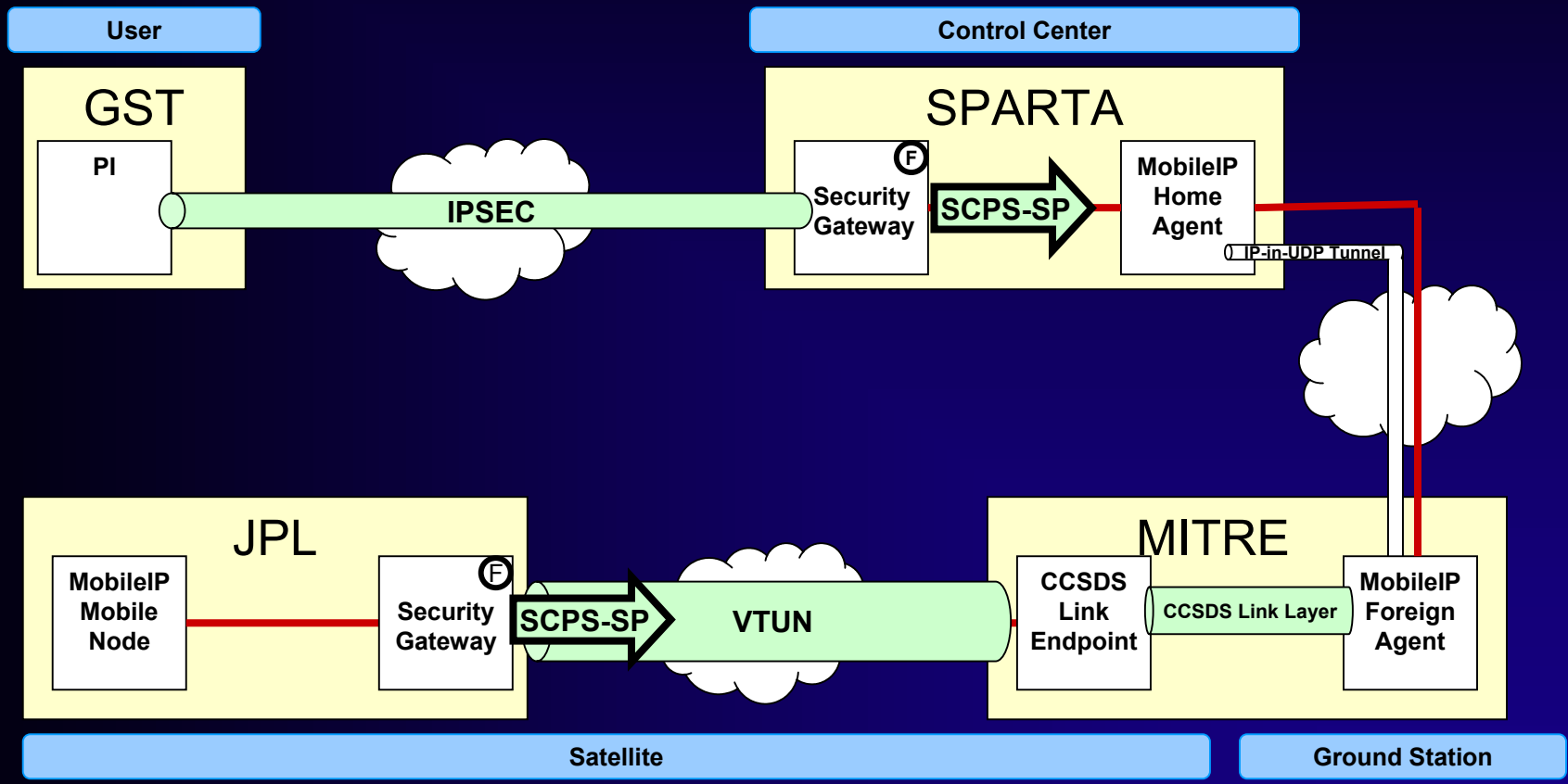
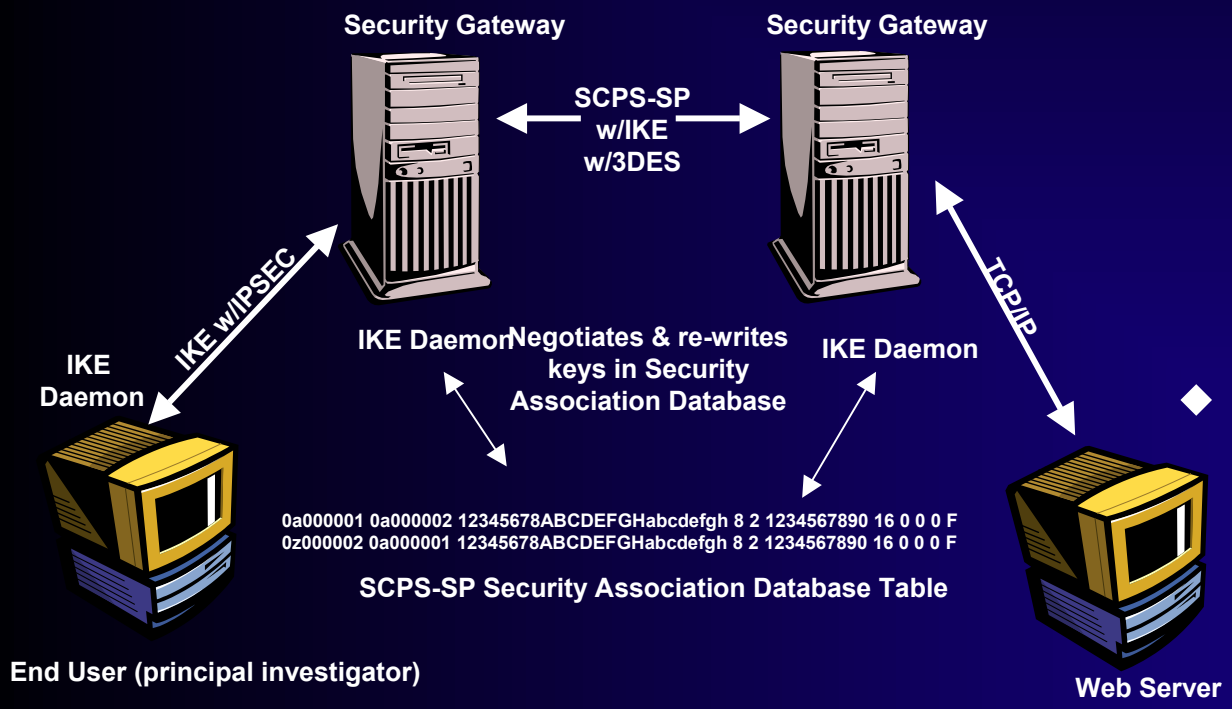
Prototype Implementation

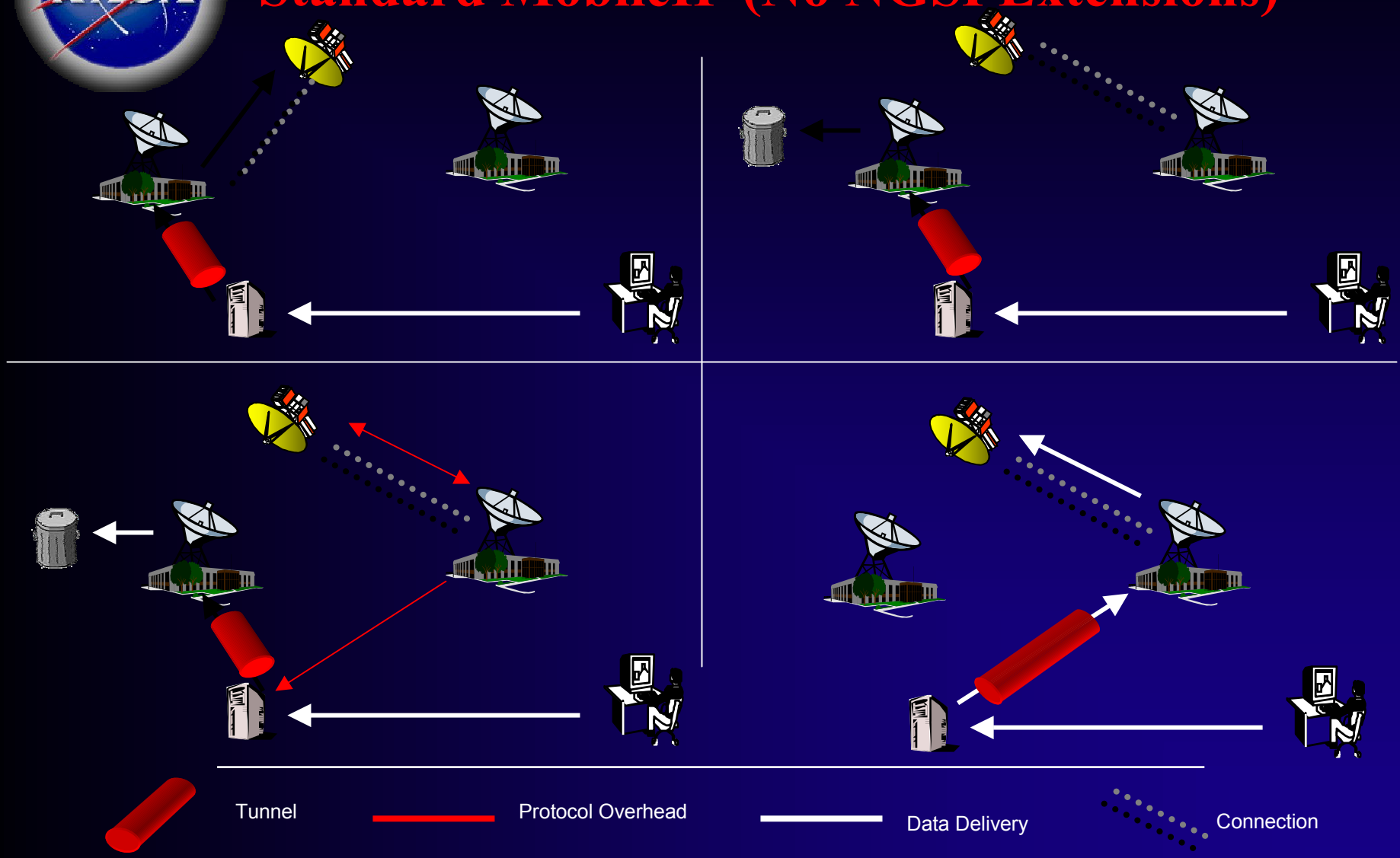


IPSEC / SCPS-SP Security Gateways

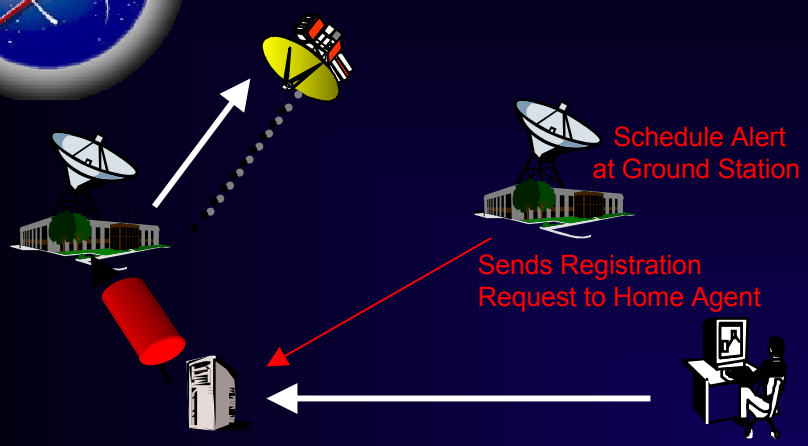


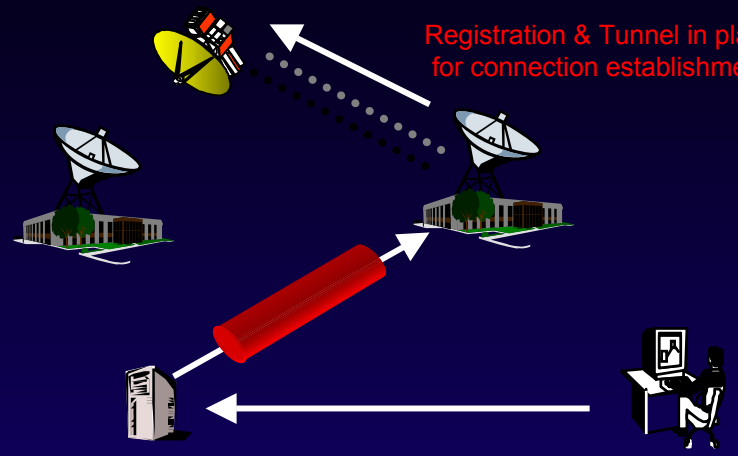
- SCPS-SP has lower overhead than IPSEC
- Trusted gateways allow
  - Logging
  - Monitoring
  - Policing
  - Transport gateways
- *Standardized IKE options for efficient key exchange*

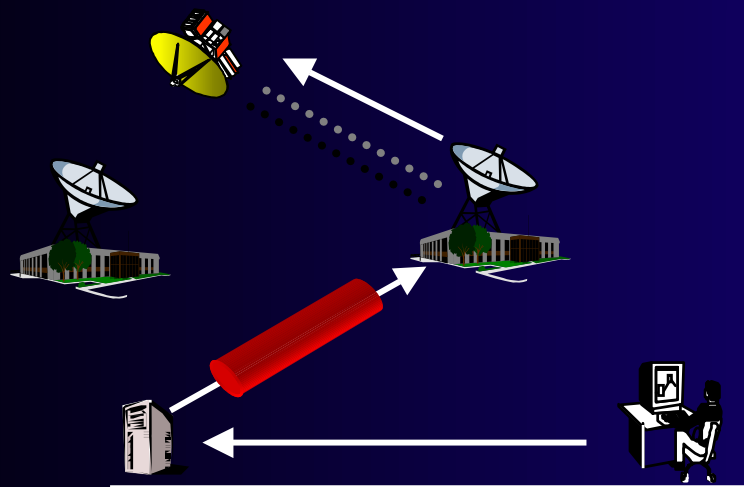
Standard MobileIP (No NGSI Extensions)



MobileIP with NGSI Extensions





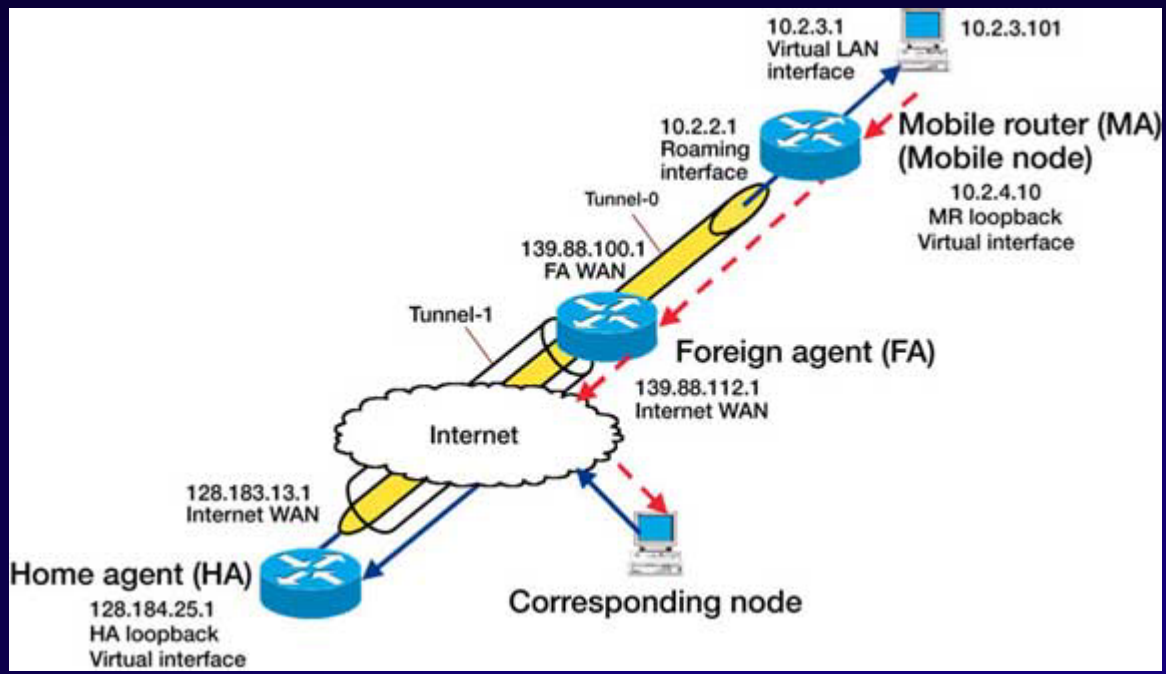


- *Standardized MobileIP extensions for scheduled operations*
  - Mobile router uses IP-in-IP tunnel and MobileIP signaling across the space link a

Tunnel Protocol Overhead Data Delivery Connection

Cisco Mobile Router

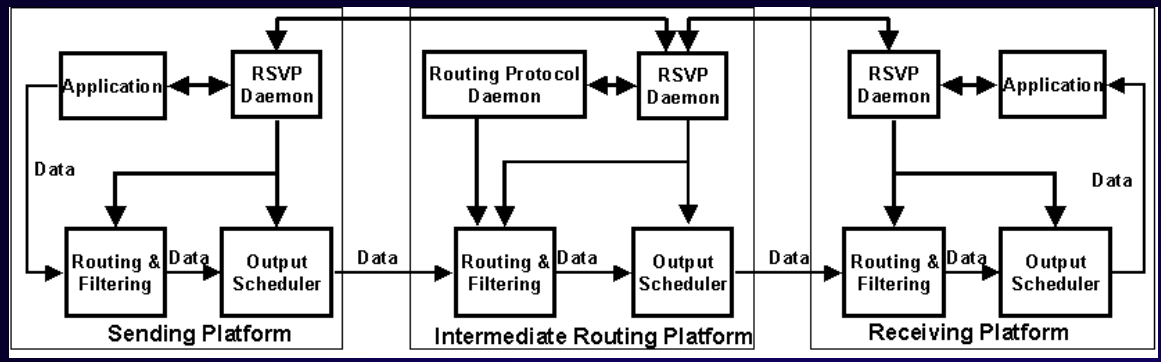
- Really designed for 'one-hop' mobile
  - Each mobile router supports a *fixed* mobile subnet
- Carries IP tunnel across the mobile channel



NGSI and Cisco Mobile Router Approaches

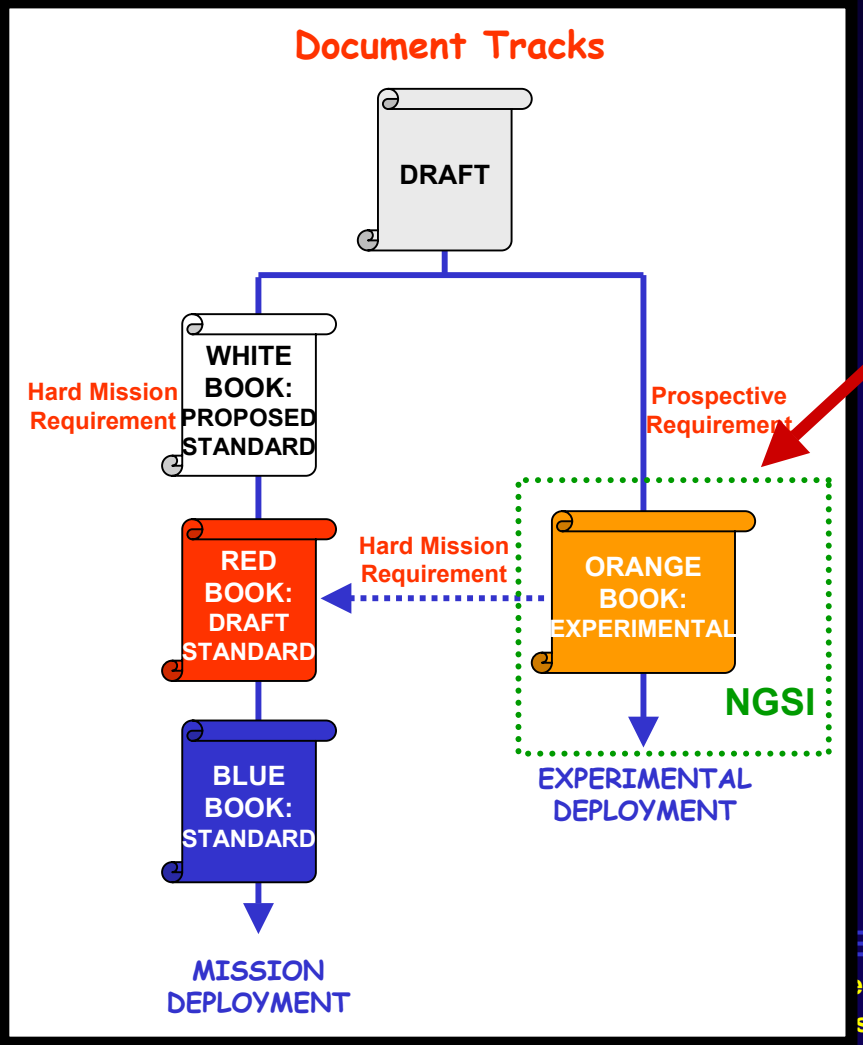
Feature	Cisco Mobile Router	NGSI
Mobile – FA Signaling (Across the space-to-ground link)	Yes – Router Solicitation / Advertisement / Mobile Registration	No – MobileIP tunnel configured ahead of time
Per-packet overhead	IP-in-IP encapsulation (20 bytes)	None
Operation in multi-hop constellation environment	Difficult for dynamic and multi-hop constellations	Yes

Internet RSVP



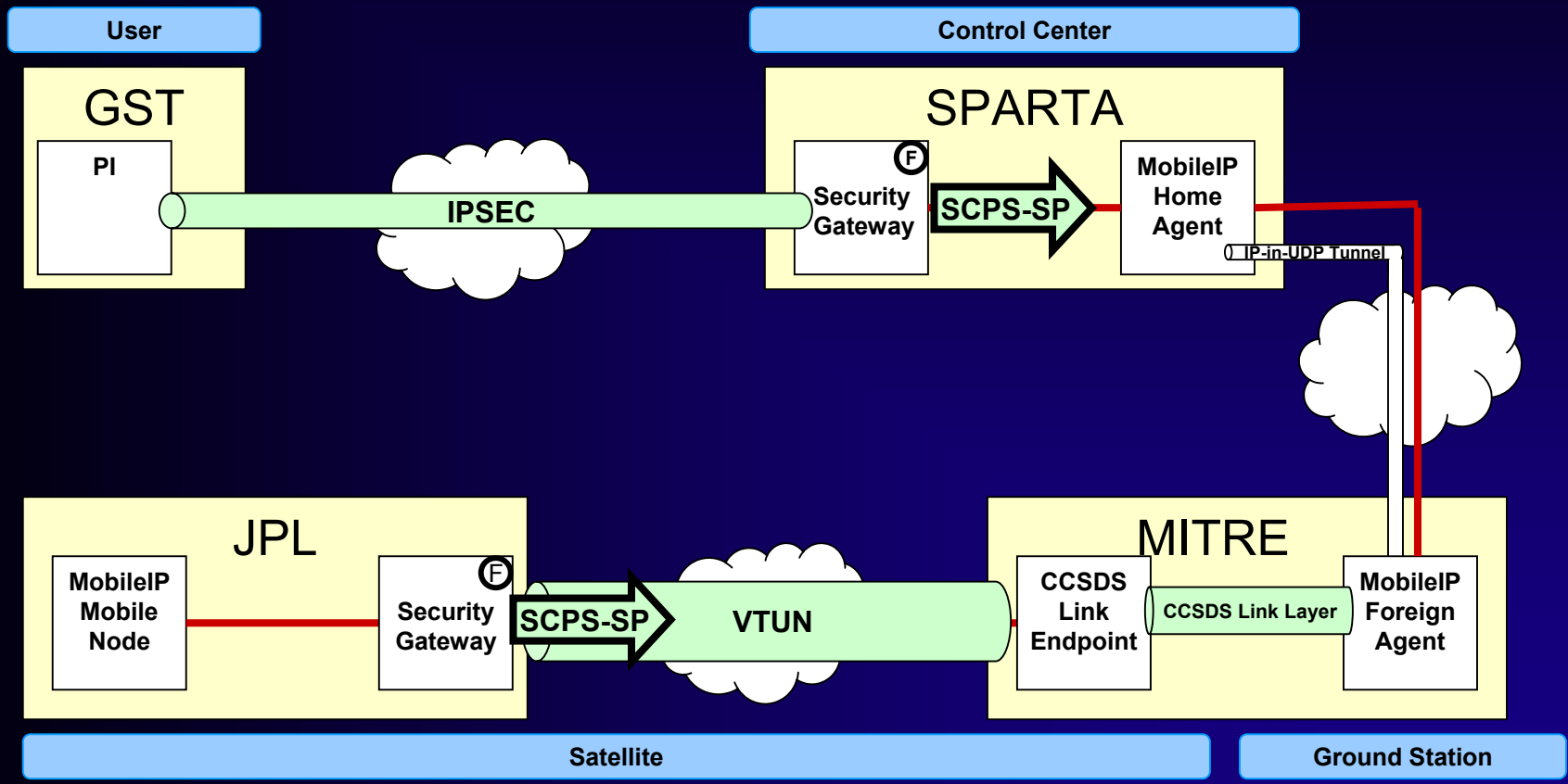
- Applications signal data requirements to the network
- Network responds (yes/no)
  - If yes, network provisions the path ➔ prevents congestion loss
- *Standardized RSVP extensions for protocol translating gateways*

Standardization



- Few missions currently requesting IP services
- Standardizing NGSI services in CCSDS 'experimental' track
  - Feedback from space agencies and interested parties
  - Can be quickly converted to standards track when appropriate

Prototype Implementation



Standards-Based Approach to IP in Space

- Runs over anything; tested with CCSDS telemetry / telecommand links
- Open international standards:
  - Can be implemented by any vendor
  - Allow international cross-support for missions
- SCPS + NGSI Maximize Data Return
  - High-efficiency network, security, and transport
    - End-to-end or via gateways
  - Low-overhead mobility support for spacecraft
  - Resource reservation to prevent congestion loss

• NASA DATA SYSTEM STANDARDS PROGRAM •

1. Interplanetary Internet: An Architectural Framework for Space Internetworking: Adrian Hooke
2. User Data Services for Internet Based Spacecraft Applications: Joe Smith
3. CCSDS File Delivery Protocol (CFDP): Tim Ray
4. Internet Protocol Based Standards for Spacecraft Onboard Interfaces: Joe Smith
5. Standard Spacecraft Interfaces and IP Network Architectures: Jane Marquart
6. Standard Transport and Network Capabilities: Bob Durst
7. Next Generation Space Internet: Standards and Implementation: Keith Scott
8. Secure Space Networking: Howie Weiss 
9. Delay Tolerant Networking: Scott Burleigh
10. CCSDS Link Layer Protocol Suite: Greg Kazz